Chart V

The Unregulated Service Fails

	Minutes	% Total	% Reg	Total	Allocated
Total	95.00			$1,000	
Non-regulated	0.00	0%			$0.00
Regulated	95.00	100%			$1,000.00
Interstate	14.25		15%		$150.00
State	80.75		85%		$850.00

Notice that in the case of a $1,000 cost, at least part of the $1,000 may have been incurred for the benefit of the non-regulated entity, but if this entity goes out of business, the LEC will still be reimbursed for the full $1,000, absent regulatory intervention.

An argument might be made that simply reallocating the costs is no assurance that the additional costs can be recovered. While this may sound reasonable, under the historical regulatory covenant between company and regulator, the company is guaranteed an opportunity to recover its expenses and earn a reasonable rate of return on investment. Under traditional rate of return regulation, if a company earns less than the authorized rate of return, it has the right to file a rate case to increase rates (revenues) with the proper regulatory agency. Under current regulation in the interstate jurisdiction, if a company earns less than 10.25 percent return on net investment for a year, the company is entitled to raise its prices in order to make up for this shortfall.

e. High Common Costs

The Commission believes that use of a fully distributed cost (FDC) methodology protects ratepayers from cross-subsidizing unregulated activities. There are circumstances under which FDC offers some protection. However, a network architecture that employs higher than necessary joint costs will still generate cross-subsidies compared to the efficient architecture.

f. Inappropriate Expensing

Another example of cost misallocation allowed by the current rules is the treatment of software expenses. In 1988, the use of Generally Accepted Accounting Principles (GAAP) was one of the prime objectives of the new accounting rules (Part 32). GAAP expenses software upgrades (not initial loads). Because these upgrades are being expensed, the current ratepayer pays for it per today's rules. Therefore, if one of the enhancements in a particular central office software upgrade is for a future non-regulated service, such as the unregulated Video Dialtone gateway, the current allocation factors would apply. When the non-regulated service becomes operational in, for example four years, this software cost would not be included in Part 64 allocations or in incremental studies because it has already been expensed.

The revenues (benefits) would be enjoyed by the non-regulated entity, while the majority of the costs was already paid by the regulated entity's customers. As the network is becoming more and more software-oriented, software expenses may be a larger cost of any new service. Therefore, this policy of expensing software upgrades may not be reasonable. The Video Dialtone implications are obvious.

g. Telephone Plant Under Construction for Video Dialtone Can Be Assigned to Telephone Ratepayers

Current rules allow the LECs to include Telecommunications Plant Under Construction -- Short Term in the interstate rate base, which means that a LEC has the opportunity to earn on this investment up to one year before it is actually put into service. If a state commission also allows this treatment, which is usually the case, then the LEC has the opportunity to earn on the entire amount of Telecommunications Plant Under Construction -- Short Term.

D. Local Exchange Carrier Cost Studies are Flawed by the use of Improper Methodology and the Absence of Verifiable Data

As demonstrated in the Appendix, the costs of equipping the existing telecommunications network to transmit broadband video signals are substantial. The cost studies provided by the LECs along with their Section 214 Applications ignore many of these costs. Moreover, gaps and ambiguities in the Commission's Accounting Rules allow the LECs to obfuscate or ignore important categories of cost.

The Oppositions to the LEC Section 214 Applications detail many problems with the LEC cost studies. In general, sufficient data are not supplied; when supplied, data are not verifiable. Revenue estimates are based upon implausible assumptions. Different iterations of the cost study provide vastly different results.[26] In addition, the LECs have adopted what amounts to a short run marginal cost standard, which ignores existing capacity costs and

[26] See the filings by the National Cable Television Association and The New Jersey Cable Association.

implies that ratepayers will be required to pay for existing capacity used for Video Dial-tone.[27]

Early in the history of the development of competition in the telecommunications industry, the Commission settled on Fully Distributed Cost (FDC) pricing due to problems with Bell System cost studies. The Bell System used different methodologies for different services and different methodologies over time for the same services. The Commission found that only by using historical cost information could it have verifiable and consistent cost data. In recent years, the Commission has moved away from FDC. However, as local exchange competition develops, and as LECs diversify into competitive businesses, the same issues that led to the original adoption of FDC are reappearing. It is becoming apparent that the Commission will have to become more aggressive in establishing standards for LEC cost studies if it is to retain incremental cost standards.

IV. NECESSARY CHANGES IN RULES AND POLICIES

Some of the apparent cost misallocations described in the previous Section are in part due to the operation of the current rules. The ability to earn on non-revenue producing equipment and Short Term Telecommunications Plant Under Construction, the "keep whole" result of relative usage and the regulatory systems under both pure rate of return and price caps, the expensing of central office switching software upgrades, and the ability to shift the payment for costs between disparate rate payers would not be sustainable or desirable in a competitive environment. Therefore, the Rules must be modified.

[27] See the Affidavit of Leland Johnson, *supra.*, p.11.

Clearly these problems are not new. They are also not easy to solve, otherwise they would have been solved. However, the complexity of the issues is not an excuse for ignoring them.[28] If Video Dialtone competition is to work, then these problems must be addressed sooner rather than later. It is not fair to either the LECs or the existing broadband video suppliers if rules regarding such basic issues as costs and revenues are not sustainable. The LECs will not be able to accurately determine their ultimate costs and revenue streams. And efficient existing providers will be damaged by cross-subsidies.

This Section describes recommended changes to existing Commission Rules that are necessary if the LECs are to be allowed into the video distribution business.

A. Part 32

The Uniform System of Accounts must be revised to allow Video Dialtone costs to be tracked and to ensure that Video Dialtone costs are not expensed to telephone ratepayers. The Appendix provides a detailed description of the changes required to equip the telephone network to provide Video Dialtone. The existing Part 32 Accounts simply do not allow these costs to be tracked and allocated properly.

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[28] The solution to the problems associated with conduct regulation is not to give up the job of limiting abuse. The best solution is to look for rules that build safeguards into the structure of the industry. Line of business restrictions and separate subsidiaries are such safeguards. Line of business restrictions work best because they remove incentives to discriminate and cross-subsidize, and thereby alter conduct. Separate subsidiaries are a second-best alternative because they make discrimination and cross-subsidy more visible and easier to detect. Of course, in some cases, line of business restrictions or separate subsidiaries are difficult or impossible to implement because the cost of separation will exceed the benefits. Cost of Service regulation must be relied upon, and the job of the regulator is to design the best accounting rules possible.

For example, Video Headend equipment that terminates circuits from programmers and connects them to a Digital Cross-Connect and Transmission facility might be assigned to the circuit equipment account along with a variety of other equipment. To prevent commingling and subsequent misallocation of these costs, a separate account or subaccount should be established for this equipment. In general, an examination of the various cost components of Video Dialtone discussed in the Appendix must be conducted in order to establish new accounts or subaccounts that allow these costs to be recorded and tracked. In particular, existing accounts must be reworked to allow separate identification of loop and trunk investments and expenses and central office software upgrades.

B. Part 36

A number of changes are necessary to update the Separations Manual to reflect Video Dialtone. Video Dialtone is an interstate service. But as described above, existing Separations Rules will allocate to the intrastate jurisdiction a substantial portion of the cost of upgrading loops to provide the service. It would obviously be desirable to modify the Separations Manual to directly assign as many Video Dialtone costs as possible to the interstate jurisdiction. However, many facilities used to provide Video Dialtone will be used for both inter and intrastate services. Therefore, the method by which these costs are allocated will have to be revisited. It may be necessary to develop separate allocators for fiber used in new construction, fiber used to replace feeder plant that is voice capacity-constrained, and fiber used to upgrade existing feeder capacity that is not voice capacity-constrained.[29]

As most participants in the process recognize, the allocation of some costs under the Separations process is, and will be, somewhat arbitrary.[30] However, as noted above, while arbitrary, these costs do have real significance to the rates paid by telephone company customers.[31] Therefore, to ignore the separations effects of Video Dialtone would not only be arbitrary, it would be anticonsumer and anticompetitive as well. The bottom line is that state and federal regulators must find some way to amend the Separations Manual to minimize the danger that an LEC choice to enter the Video Dialtone business causes basic local service rates and access charges to be higher than they would otherwise be.[32]

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[29] The relative usage concept itself must be examined and perhaps replaced with appropriate fixed allocators. In addition, it will be necessary to use Class A Account detail in the Separations process to prevent excess allocations to the common line category.

[30] Appropriate pricing of Video Dialtone raises separate issues. The incremental cost studies used to justify the pending Section 214 Applications are seriously flawed. Total service long run incremental cost (TS-LRIC) is generally preferred over simple long run incremental cost pricing because, under the latter, monopoly services will be burdened with paying for costs incurred to produce competitive services. If costs are rising, then marginal cost becomes the effective price floor. See William J. Baumol, Superfairness (1986) for a discussion of TS-LRIC pricing.

[31] Moreover, there is an apparent Constitutional requirement to separate costs.

[32] Note that neither a price cap nor a price cap with a modest productivity adjustment necessarily guarantees this result to consumers. First, as discussed earlier, existing rates may well contain embedded Video Dialtone costs. Second, there is good reason to believe that the cost of providing POTS should be falling dramatically, in line with the dramatically falling costs of computer and digital transmission equipment.

C. Part 64

Part 64 CAMs should be modified to require identification and attribution of previously expensed Video Dialtone items and should be reviewed to insure that directly assignable Video Dialtone costs are in fact being directly assigned. In addition, the Accounting separations rules must be changed to minimize transfers of expenses and investments back to the regulated category when demand for unregulated services fails to materialize.

D. Part 69 and Price Cap Rules

Separate access charge categories for Video Dialtone are necessary, and a separate Video Dialtone Basket should be established. Absent these changes, there is obviously a risk that Video Dialtone expenses allocated by the Separations process to the interstate jurisdiction will be misallocated to existing access charge categories. Moreover, as the Commission has discovered both in the context of ONA BSE pricing and the Transport Docket, the new service provisions of price caps are simply inadequate to protect ratepayers. This is obviously the case for Video Dialtone as well. Finally, the Commission should require basket by basket earnings calculations and sharing to prevent Video Dialtone losses from triggering upward rate adjustments in other baskets.

E. ARMIS

The Commission's Automated Regulatory Management Information System (ARMIS) is an essential tool for monitoring what is happening to various USOA, Separations, and Part 69 Accounts. Several steps are necessary to refine ARMIS for a Video Dialtone world. In particular, the Reports should provide detail on fiber v. copper investment and expenses. In addition, Report 43.02 should provide Company Service Area (COSA) data instead of company data.

V. VIDEO DIALTONE COST MISALLOCATIONS CAN HAVE LARGE IMPACTS ON MONOPOLY RATEPAYERS

The cost of upgrading copper loops to fiber for providing a nation-wide fiber optic network are difficult to estimate and depend on the particular architecture selected by the LEC. U S West recently announced plans to spend about 1,000 dollars per line for a "fiber-to-the-neighborhood" architecture.[33] If this amount of investment were to undertaken nation-wide, the total cost would be approximately 137.5 billion dollars. Investment in regulated facilities translate to revenue requirements, and ultimately into rates. Today each dollar of cable and wire investment translates into 38 cents of annual revenue requirement. Using this expense factor, the annual nation-wide revenue requirement associated with investment of 1,000 dollars per line would equal 52 billion dollars.[34]

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[33] See "U S West Announces Plan to Deploy Broadband Network Across its Service Territory," Telecommunications Reports, February 8, 1993, pp. 6-8.

[34] This number exceeds existing cable revenue from subscriber services by a factor of approximately 2.5. See National Cable Television Association, Cable Television Developments, October 1992, p. 8-A.

There is no guarantee that broadband could actually be deployed for 1,000 dollars per line. Moreover, other architectures that have been discussed, such as fiber to the home or alternatives involving on-demand switched video, would cost substantially more. Reed provides estimates of the cost of various architectures of as high as 2,500 dollars per household, resulting in nationwide costs well in excess of 200 billion dollars.[35]

Thus, it is reasonable to conclude conservatively that we are dealing with nation-wide broadband investment costs in the range of at least 100 to 200 billion dollars. Revenue requirements associated with these investments range from 38 to 76 billion dollars. If even ten percent of these costs were to be misallocated to basic monopoly services, consumers would pay from 3.8 to 7.6 billion dollars a year more than they should. In a recent Commission proceeding, LECs reported that transport revenue requirements were inflated by as much as 13 percent.[36] Therefore, cost misallocations in the range of ten percent are not unimaginable.[37] But a ten percent cost misallocation would only be the tip of the iceberg if

[35] Reed, *supra*, Appendix B, Tables B.11-B.15. There are approximately 97 million households in the U. S.

[36] See Comments of Pacific Bell and Nevada Bell, In the Matter of Expanded Interconnection with Local Telephone Facilities, CC Docket No. 91-141, August 6, 1991, p. 27. The Commission has instituted a proceeding to deal with the misallocation of General Support Facilities by changing the existing Part 69 Access Charge Rules. See Report and Order and Notice of Proposed Rulemaking, In the Matter of Expanded Interconnection with Local Telephone Company Facilities; Amendment of the Part 69 Allocation of General Support Facility Costs, released October 19, 1992.

[37] The recent GAO Report notes that "...FCC auditors have found cases of misallocations totaling over $300 million in which carriers charged expenses to the regulated side of their business and carriers' affiliates had overcharged regulated carriers for services and supplies," *supra.*, p. 12.

most of the broadband expense represents replacement or upgrade of copper facilities that would otherwise be adequate for narrowband service.

Page Montgomery, using conservative assumptions, found that a proposed Pennsylvania Bell accelerated fiber deployment program would cause revenue requirement per access line to increase by 20 dollars per month over a "business as usual" fiber deployment program.[38] Using today's figure of 137.5 million local loops and extrapolating the Pennsylvania estimate nation-wide implies that, absent effective safeguards, accelerated fiber deployment could increase telephone rates by 33 billion dollars per year.

As discussed in the Introduction, the existing jurisdictional separations rules would assign 75 percent of the fiber loop costs, but none of the revenues, to the intrastate jurisdiction. Therefore, the jurisdictional cost misallocation of fiber investments of the magnitude under discussion here would cause local revenue requirement increases to approach 28.5 to 57 billion dollars, unless the Commission takes steps to revise the rules.[39]

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[38] Accelerated Broadband Networks: The Costs and Risks, *supra.*, p. 29.

[39] 200 billion in investment times the 75 percent jurisdictional allocation times the 38 percent revenue requirement factor equals a 57 billion dollar jurisdictional misallocation.

VI. CONCLUSION

The magnitude of the investments and the extent to which they will be misallocated can be debated. But there is no question that Video Dialtone puts billions of ratepayer dollars at risk. Business as usual regulation of Video Dialtone investments and expenses will most certainly lead to cost misallocations. Given the way that the existing rules operate, basic telephone rates are likely to rise as a result. Therefore, the Commission's accounting and cost allocation rules must be revised to reflect Video Dialtone.

APPENDIX

EQUIPPING A LOCAL EXCHANGE NETWORK
TO PROVIDE VIDEO DIALTONE REQUIRES SUBSTANTIAL COSTS

Equipping an LEC network to provide Video Dialtone Service is a substantial undertaking. This Appendix describes the changes that would be required, in order to illustrate the magnitude of the job and to show why the existing Accounting Rules, to be discussed in Section III, must be modified. If the Commission's cost allocation rules are to work correctly, they must be based on an understanding of how services are provided.

Several architectures for providing video signals over the local exchange network are possible. The discussion below begins with the LEC (or more narrowly, Bell Operating Company (BOC)) vision of a generic Fiber-in the-Loop (FITL) system, as described in Bellcore document TR-NWT-000909. This is augmented by a description of the video switching and control elements in the LEC CO, since the FITL description deals only with the "loop," or distribution network, and by more specifics on what happens at and near the customer premises. For the switching, control, and premises elements, the discussion first considers examples of a system that is commonly described in Video Dialtone proposals before the Commission, namely Broadband Technologies' Fiber Loop Access (FLX™) system. It also uses references to various components of that example system in discussing the FTTL systems. The discussion then evolves into a description of the Broadband Integrated Services Network (BISDN), that, in the LECs' view, is the likely ultimate delivery system for Video Dialtone and all other broadband services.

Some LECs are proposing to initially offer what they refer to as a Video Dialtone Service using Asymmetrical Digital Subscriber Line (ADSL) technology. Given its inherently limited capacity, this architecture may not conform to the requirements of Video Dialtone. However, given that some LECs are planning to deploy ADSL, the Commission's Accounting Rules should be robust enough to allow proper assignment of the costs. Therefore it is also useful to describe the costs that would be incurred in provisioning ADSL.

A. Premises Components

Under any Video Dialtone scenario, there are two primary premises components: a conversion device, and the premises distribution cabling. The nature and format of the signal reaching the various kinds of terminals that might be present at the premises -- television sets, telephones, computers, and so on -- must be compatible with those devices. The conversion device translates between the format of various signals carried over the network and the format required by the terminals themselves. The need for this device is obviated if such conversion is provided elsewhere in the network.

In the case of video services delivered to a television set, for instance, the conversion device might have to accomplish two major functions: 1) converting a digitized television signal to the standard 6 MHz analog NTSC format -- or, in the future, some other standard appropriate to, say, HDTV -- and 2) processing user-generated control inputs, such as channel selection, into a control signal suitable for upstream transport to the control elements of the network. It can be thought of as an enhanced version of today's cable system converter box, and is likely to be similar in size. In early Video Dialtone systems, the control signals are likely to be coupled to, and transported to the CO over, the POTS circuit into the premises. Later, under a BISDN scenario, they may be transported over an upstream digital channel provided as part of BISDN, as discussed later. In the example FLX system, the conversion device is called the Digital Video Terminal (DVT), and it provides for upstream signaling via POTS.

The premises cabling connects the terminals and/or conversion devices to the network interface at the entry point into the premises. In early Video Dialtone systems, this cabling will be the existing wire pairs and coaxial cable. These may later be augmented by premises fiber and perhaps even a wireless medium in some cases.

B. FITL System Components

The FITL system lies between the LEC CO and network interface at the premises. It is intended to support all applications -- POTS, narrowband data, and, ultimately, broadband data, in addition to video. Thus, some means must be found to fairly allocate the cost of the shared FITL components between the various uses to which it is put. The Bellcore FITL model includes the following components. The FLX system is largely consistent with this FITL model.

(1) The network interface itself. This discussion assumes the interface remains extremely simple -- a connector and appropriate environmental protection -- with all other functionality being attributed to the Optical Network Unit or other FITL components.

(2) The drop from the pedestal to the premises. This may be a combination of twisted wire pairs, coaxial cable, or, in later stages, fiber or radio.

(3) The Optical Network Unit (ONU). This unit provides all or some of the necessary conversion between the fiber transmission medium and the signal formats used in the network and the medium and format used for the drop and by the premises equipment. In the extreme case of ONU signal conversion, the signal at the premises side of the ONU might be in the form needed for direct input to the terminal devices. In that case, no further conversion is needed at the terminals, although there may still be a device there to accept control signals from the user. More typically, the ONU will

provide O/E conversion and other forms of optical signal processing, and derive the signal intended for a particular premises from a composite signal, while the device at the terminal still needs to, say, convert digital signals into analog inputs to television sets.

In summary, the network side of the ONU matches the characteristics of the distribution system, which, for instance, might mean it supports a SONET interface. The customer side of the ONU provides interfaces appropriate for the tariffed telecommunications services it supports -- POTS, narrowband ISDN, video channels, and the like.

Initially, the ONU is envisioned to be at a pedestal near the premises and serving several premises. This is the case with the FLX System, in which the ONU is called the Multi-Subscriber ONU (MSONU). Later, however, the ONU may move to the entry point at the individual premises. In this case, there would simply be splicing and passive signal splitting at the pedestal, with a fiber drop to the ONU at the individual premises.

A key ONU requirement, whether it is in a pedestal or at the premises, is powering. Since the FITL system utilizes fiber optics, which cannot conduct electricity as twisted-wire-pair systems can, the ONU, which is an active device, must derive power from somewhere. This is envisioned as either being done locally, tapping a commercial electrical utility, or over the network using copper wiring included in the fiber sheath to carry electricity. The former case requires battery backup to avoid loss of telephone service when commercial power is interrupted. Whichever method is used, powering of the ONU and the premises devices represents a significant cost and complexity to the LEC.

(4) <u>A so-called Passive Distribution Network (PDN)</u> connecting the ONU to a device called the Host Digital Terminal (HDT) located further upstream. The PDN will consist of the fiber optics transmission medium and passive optical devices, including splitters and combiners, that allow multiple ONUs to be subtended by a single HDT. Potentially it could also include optical amplifiers. Its role is to distribute the same signal from the HDT to all of the subtending ONUs.

(5) <u>The HDT, which provides the interface between the DCTF (below) and the PDN</u>. Being active, it includes all necessary signal conversion, selection, multiplexing, and the like to insure the proper signal is sent to each of its subtending ONUs. The HDT may be in the CO. More typically, it is located at what today would be called a Serving Area Interface (SAI). In this latter case, the HDT is the broadband equivalent of today's loop carrier system remote terminal. The FLX system uses the HDT terminology, and envisions it being in either the CO or a remote site.

An advanced form of the HDT may be able to perform an actual switching function, to couple individual broadband signals arriving from the CO to particular ONUs via the PDN. This analysis assumes, however, that switching is done in the CO, so the HDT only has the carrier termination and PDN coupling function.

(6) A Digital Cross-Connect and Transmission Facility (DCTF), which connects the switching system to the HDT. If the HDT is collocated in the CO, the DCTF consists of various kinds of fiber optics transmission equipment, broadband cross-connect systems, and fiber distribution frames. If the HDT is remote, the DCTF also includes fiber transmission facilities from the CO to the remote site. Thus the DCTF is the broadband equivalent of today's loop carrier system. When the HDT is at the SAI, one can draw the following analogy: the DCTF is the broadband equivalent of today's loop carrier (or "pair gain") system in the feeder portion of the outside plant, while the PDN is the equivalent of the distribution portion of the outside plant.

(7) Operations Support Systems (OSS). These provide management functions such as circuit/service provisioning, performance monitoring, and maintenance. Typically, the communications capabilities of the FITL system includes network management data channels that allow such management information to be communicated between the elements of the FITL and the OSS themselves. Costing must account for the management data overhead as well as the OSS. In the FLX system, there is an interface between the HDT and LEC OSS called the Remote Administration Module. It supports circuit and equipment provisioning, line and equipment testing, and performance testing.

C. Switching and Control Functions

The CO part of the Video Dialtone system has a number of components. Excluding the HDT, which may be in the CO but has already been accounted for in the FITL part of the system, the remaining elements follow.

(1) A video headend (VHE). At a minimum, this device terminates circuits from the video information providers (VIPs), and couples those circuits to the DCTF. This simple case envisions that all control signals have been passed to the VIPs themselves, who have used them to determine the program content of each signal sent to the CO, so that the CO coupling can be static. Note that all multiplexing and cross-connect functions which are needed to distribute the individual signals from the VIPs to the appropriate HDT(s) have been accounted for in the DCTF.

The VHE may also perform other functions. It may convert the incoming baseband analog signals from the VIPs to digital form, including compression to increase the channel content of each fiber (of course, there must be matching decompression and

D/A conversion in the set-top conversion device or the ONU). Also, to the extent that multiplexing and cross-connect functions have not already been provided in the DCTF, those functions may also be included in the video headend. Finally, a sophisticated VHE may do dynamic switching and/or cross-connect functions in direct response to control signals from the gateways discussed next.

(2) The first-level gateway (FLG). The FLG provides a video menu display to the users, receives control signals from the users, and passes those signals to the appropriate second-level gateway (SLG) of the selected VIP. In the FLX system, the FLG is referred to as the Video Administration Module. Associated with the FLC, there must also be a) a video channel from the FLG to the VHE; b) a mechanism for extracting control signaling information from the users and passing it to the FLG (the extraction function may be done in the HDT); and c) the circuit for carrying control information from the FLG to the SLG. Note that while this discussion, and the FLX system, consider the VHE and FLG to be separate devices, the FLG function could simply be part of the VHE.

(3) The SLG hardware/software platform. Although the Video Dialtone rules require the SLG be provided by the individual VIP, this analysis assumes there will be an issue as to whether the rules are referring to the SLG content only, or the platform as well. To the extent this is an unresolved issue, it anticipates the LECs may try to offer the SLG platform for use by independent VIPs.

(4) Inter-office (or within-office, for collocated VIPs) broadband channels and control/operations circuits to the VIPs.

D. The BISDN Scenario

When and if the early Video Dialtone systems evolve into BISDN, several changes will occur in the premises, loop, and CO components of the system. An overriding consideration in this scenario is that most of the components are now shared by all video and non-video applications in a highly integrated fashion.

In its briefest possible description relevant to the purposes of this analysis, the BISDN scenario assumes that information for all applications is transmitted and switched in an integrated fashion in the form of small "cells" of information. This form of transport is called Asynchronous Transfer Mode (ATM) switching, or sometimes Cell Relay. The cells are conveyed over an all-fiber SONET transmission system, with the cells being carried in the payload of SONET frames. They are switched on a cell-by-cell basis; cells carry an identifier that indicate their source and destination. The identifier to be used for each connection is assigned by network control elements as the connection is established.

The changes in the components of the Video Dialtone system when it evolves to BISDN are summarized below. They are ordered as their corresponding early Video Dialtone system components appeared in Subsections A through C. The BISDN components should be assumed to be used in an integrated fashion by all applications, unless they are noted below as being unique to video services.

(1) The set-top conversion device is replaced by a signal converter and ATM multiplexer serving all applications. The ATM accepts "native"[1] signal inputs from each kind of terminal and application, converts them to ATM cells, and multiplexes those cells for transmission over the network.[2] It also does the reverse for signals arriving from the network. The device also conducts the necessary control dialog with the network to establish connections, assign ATM cell identifiers, and obtain the amount of network capacity needed for each connection that is in effect. It is thus a sophisticated device. As in the case of the Video Dialtone conversion device, these functions can be moved to the ONU, with native signals being transmitted from the ONU to the terminals.

(2) While the ONU may be in a pedestal or at the premises, the common assumption is that for full BISDN, it will be at the premises, with a fiber drop from the pedestal to the premises. A SONET multiplexing function is required in the ONU, although that function may also be moved into the ATM multiplexer. Presumably, the ONU still includes O/E conversion and powering, so the ATM stream delivered to the premises is electrical.

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[1] For example, a 3 KHz analog signal to/from telephones, a digital data stream to/from data terminals, a 6 MHz analog NTSC signal to the television sets, etc.

[2] In a further evolution, terminal devices themselves may generate and receive ATM cells and carry out their own control dialogue with the network, in which case this component is limited to multiplexing.

(3) The HDT changes only to the extent that SONET is not already in use in the DCTF and PDN. For both the PDN and DCTF, and particularly the DCTF, SONET will likely have achieved significant penetration prior to BISDN. The HDT will act as a SONET multiplexer/demultiplexer, with a higher-rate signal on the DCTF side being decomposed into lower-rate signals over the PDN.

(4) The same comment pertains to the DCTF: to the degree that it has not already been converted to SONET, the conversion of all devices -- multiplexing, cross-connect, optical terminations, and the like -- to SONET will be necessary to deploy BISDN.

(5) The video headend will be replaced by an ATM switch. With respect to Video Dialtone, it will switch the video signals between the VIP circuits and the DCTF circuits to the HDT. It must also extract the ATM cells carrying customer control signaling, and pass them to the FLG.

(6) The FLG must be able to send/receive ATM cells; and provide conversion of the video signal that conveys menu information to ATM cells; but otherwise, its functions are the same. The FLG is unique to Video Dialtone.

(7) It is conceivable, although not mandatory, that the Video Dialtone control mechanism involving the ATM switch, FLG, and SLG will utilize the intelligent network (IN) concept, in which the FLG would essentially become an intelligent peripheral or adjunct communicating with the ATM switch and the SLG via SS#7. If IN is not applied to BISDN, then the ATM switch will require some other mechanism for receiving and acting on control information received from the FLG and/or SLG.

(8) The OSS will evolve to a full SONET-based management scheme, in which SONET overhead is used to convey the management information between the network elements and the OSS.

E. Video Signals Delivered via ADSL

Finally, there may be an initial video system which uses the ADSL technology. ADSL is a copper-based technology involving the downstream (CO to premises) transmission of a 1.5 Mbps T1 signal suitable for VCR-quality video, and a 16 Kbps two-way upstream channel for signaling. These are frequency division multiplexed onto the same wirepair that is carrying the voice or possibly Basic Rate Interface narrowband ISDN signals to/from the premises.

The following ADSL components would be involved in providing Video Dialtone:

(1) A premises converter, that converts/muxes from the composite FDM signal on the network to customer-side separated video, voice, and signaling signals.

(2) Intermediate multiplexing at the Serving Area Interface (i.e., the remote terminal). In the downstream direction, it extracts the T1-rate video signal, and DS-0 voice and data signals, off the DCTF or conventional loop carrier system and forms the composite ADSL signal to the premises. In the upstream direction, it performs a much more conventional multiplexing of voice and data signals onto DS-0 channels in the DCTF.

(3) CO multiplexing -- extracts the various signals in the composite ADSL signal and connects them to the appropriate elements: signaling data to the FLG, T1 channel to the video headend, and POTS and/or ISDN signals to the CO switching system.

The remaining elements are as in the initial Video Dialtone description, with the understanding that the VHE might do the video to compressed digital format suitable for ADSL transmission.

F. Other Relevant Costs

Many of the cost elements identified above require additions to the existing network. In other cases, existing network components have been augmented to provide capacity for broadband video transmission. There is no question that the LECs have been preparing for a number of years to enter the Video Dialtone business, or something like it. Rather than optimizing their networks to provide efficient and low cost traditional voice and data services, the LECs have been preparing for an integrated network. The entire difference between the cost of an optimized POTs network and the actual network in place today should be assigned to Video Dialtone and recovered from broadband video customers. Examples of such costs include: broadband development costs (including Bellcore costs), unnecessary fiber installations, excess fiber capacity, and over-sized pedestals. For example, the LECs have been deploying large amounts of fiber in the inter-office and feeder portions of the network. To the extent that fiber has been deployed in excess of the amount required for narrowband services, costs have been inappropriately assigned to existing narrowband ratepayers.[3]

The LECs may try to argue that there are economies of scope between broadband and narrowband services. However, this is unlikely to be the case. Broadband and narrow band services place different requirements on the network, thus reducing the potential for scope economies. For example, the integrated network might be built with performance availability and other attributes that are more stringent than those required for broadband systems.In other words, attempting to "squeeze" broadband capability into the existing narrow-band platform may actually cost more than separate, specialized broadband and narrowband systems.[4]

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[3] Other examples are carrier system terminals that utilize transmission speeds that reflect broadband requirements, controlled environment vaults whose physical characteristics are determined by the size or amount of equipment required for broadband services, and operations support systems built with sufficient flexibility to accommodate broadband transmission.

[4] See Hatfield Associates, Inc., "The Economics and Technology of Video Dialtone," *supra.* for a detailed discussion of the scope economies issues.

ATTACHMENT

Hatfield Associates, Inc. (HAI) is a Boulder, Colorado based telecommunications consulting firm. Since its formation in 1982, HAI has provided analyses and recommendations in virtually every area of telecommunications including mobile radio, cable television, local distribution/bypass alternatives, long haul communications, customer premises equipment and BOC network architecture.

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Daniel Kelley is a Senior Vice-President for Hatfield Associates, Inc. (HAI). Prior to joining HAI, he was Director of Regulatory Policy at MCI Communications Corporation. Dr. Kelley was with the Federal Communications Commission from January 1978 to September 1982 where he held positions in the Chairman's Office, the Office of Plans and Policy and the Common Carrier Bureau. He was with the Antitrust Division, U.S. Department of Justice, from September 1972 to January 1978. At the Justice Department he analyzed competitive effects of mergers and business practices in a wide variety of industries including telecommunications, newspapers, and securities, and served on the economic staff of U.S. v. AT&T. He received a Ph.D. in Economics from the University of Oregon in 1976, an M.A. in Economics from the University of Oregon in 1971, and a B.A. in Economics from the University of Colorado in 1969.

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